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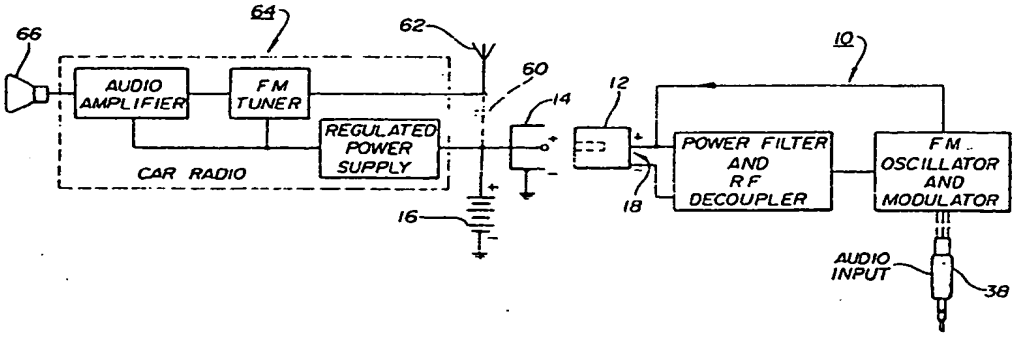
(54) Title: ADAPTER FOR CAR RADIO

(57) Abstract

A stereophonic or monaural adapter is connected to an FM automobile radio via the cigarette lighter of the vehicle. The adapter can connect monaural (Fig. 2) or a stereo signal (Figs. 3A and 3B) generating device, such as a cassette tape player or a compact disc player directly to the sound system of the vehicle via the cigarette lighter receptacle. A transistor modulator-oscillator (65, 71) stage is provided which generates an output (7) indicative of the stereo channels. The stereo channels (2, 4) are multiplexed as an input to the oscillator. The weak signal (7) thus generated is coupled to the vehicle's radio via the stray capacitance of the wires connected to the common power source or battery of the vehicle, and the proximity to the antenna and input stage of the vehicle's radio. The oscillator (65) is tuned to an unused location on the FM radio dial so that the audio signal generated by the cassette or compact disc player (2, 4) can be heard without interference with or from the local FM commercial radio frequencies.



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Title: Adapter For Car Radio

S P E C I F I C A T I O N

Cross Reference To Related Applications

This application is a continuation-in-part of pending application, Serial No. 832,811 filed February 20, 1986, which is, in turn, a continuation-in-part of pending application, Serial No. 764,786 filed August 12, 1985. All applications are commonly assigned.

Background of the Invention:

Field of the Invention.

As disclosed and claimed in U.S. Patent Application Serial No. 764,786, filed August 12, 1985, a portable cassette tape player or other audio signal source can be connected to an FM automobile radio through an adapter having an input plug which is inserted into the audio signal output terminal of a tape or compact disc player and an output plug which is inserted into the cigarette lighter of the vehicle. The direct voltage from the car battery is filtered and connected to a frequency modulation oscillator stage in which the audio signal from the player frequency modulates the oscillator. The weak frequency-modulated signal thus generated is coupled into the FM car radio through the cigarette lighter receptacle via stray capacitance of the wires connected to the common power source or battery, and the proximity to the vehicle's antenna and the input stage of the radio. A

tuning capacitor tunes the oscillator frequency to an unused location on the FM radio dial between local FM radio stations so that the audio signal can be heard on the normal FM radio band of 88-108 MHz over the car radio's loudspeakers with minimum noise and interference.

The invention of patent application 832,811, filed February 20, 1986, is an improvement to the circuit described in the aforementioned 764,786 application in that the 764,786 application discloses a monaural coupling of the stereo tape recorder to the FM car radio. The invention of 832,811 is a stereophonic adaptation of the monaural circuit such that the car radio's FM stereo capabilities can be fully utilized when coupled to a stereophonic audio source such as a cassette tape recorder or compact disc player.

As taught in the 764,786 application, the audio signal is coupled to the radio via the generation of a frequency-modulated low power signal from an RF oscillator. The output of this oscillator is coupled to the wiring system of the vehicle via the car's cigarette lighter. The signal is detected by combination of the car's wiring, and the location of the input of the radio and the radio antenna relative to location of the cigarette lighter via stray capacitance and carrier current effect.

The stereophonic version utilizes the same coupling principles as is taught in the monaural disclosure. Specifically, a low power FM signal is generated indicative of the right and left channels of the stereophonic input from the audio player. This signal is again coupled via the car's cigarette lighter to the FM stereo radio in the vehicle through the combination of the vehicle's wiring system and the locations of the antennae and the radio relative to the cigarette lighter along with the carrier current effect.

DESCRIPTION OF THE PRIOR ART

Presently known car radio tape players employ a combined unit that is installed in the automobile dashboard. The radio may be used separately or switched to connect to the output of the adjacent tape player. The cartridge or cassette tape is inserted into the tape player and heard through the speakers of the radio. A typical example of such a device is shown in U.S. Patent No. 3,751,601 wherein a selector switch connects the tape player directly to the input amplifier of the radio or connects the radio to the automobile antenna. The tape player includes an audio amplifier, oscillator, and modulator which provide a modulated radio frequency signal to the radio. Another similar device is shown in U.S. Patent No. 2,959,644, wherein the amplified amplitude modulated RF signal from an accessory tape player is connected to the radio antenna input of a standard AM radio through a plug. These devices, however, required an expensive tape player and radio to be installed in the automobile and could not be used with a separate portable stereo cassette player of a type that can be carried by an individual.

SUMMARY OF THE INVENTION

It is therefore a primary object of the present invention to provide a device that permits a portable stereo cassette player to be connected to an FM car radio.

Another object of the present invention is to apply the radio signal from a portable tape player to the car radio to be heard over the radio loud speakers without a direct connection to the input stage or antenna of the radio.

A further object of the invention is to utilize the car cigarette lighter receptacle to couple the audio signal from a portable tape player into the car radio.

A still further object of the invention is to utilize the car cigarette lighter receptacle to provide a connection to the car battery as the source of power for an adapter device to apply the audio signal from a portable tape player to the car radio.

Yet another object of the invention is to permit an FM car radio to play stereo cassette tapes from an external portable tape player without requiring installation of an expensive tape deck in the automobile.

An additional object of the invention is to provide a relatively simple inexpensive adapter device to permit a tape recording from an external portable cassette player to be connected to the car radio and heard over the radio loud speakers.

It is also another object of the invention to provide an adapter device between a portable cassette player and an FM car radio which utilizes a standard stereo miniature plug to connect to the stereo cassette player and a cigarette lighter plug to connect to the car radio.

It is a further object of the invention to provide an adapter device between a portable tape player and an FM car radio which does not require an antenna, an amplifier, or a separate power supply and operates on very low power.

It is an additional object of the invention to permit a stereo cassette player to be connected to an FM

car radio with minimum noise and no interference with normal broadcasting station frequencies.

It is a principle object of the present invention to provide a device that permits portable stereo audio source to be utilized in connection with an FM stereo car radio preserving the stereo effects in the vehicle. Another object of the present invention is to enable the use of a portable audio player with a car radio such that the player can be conveniently connected and disconnected from the vehicle for continued use as a portable player.

A further object of the present invention is its provision of cassette or compact disc reproduction capability in a vehicle without the necessity of incorporating a player in the vehicle, but rather, utilizing a stereo source in the vehicle as well as in other environments for which it was designed.

A further object of the present invention is the provision of a means for connection of an audio player to the sound system of the vehicle via the car's cigarette lighter only. A further object of the present invention is to enable connection of a stereo player to a vehicle's sound system without the necessity of any special wiring, electrical connections, or other connections which require any skill or special tools on the part of the vehicle's operator.

A further object of the present invention is to enable stereo cassettes or discs to play through the vehicle's stereo FM radio without any modifications or interruption of the ability of the FM radio to perform in its normal manner.

BRIEF DESCRIPTION OF THE DRAWINGS

These as well as other objects and advantages of the present invention will become apparent to those skilled in the art from a review of the following specification and accompanying drawings in which:

Fig. 1 is a schematic block diagram of the system including an FM car radio and cigarette lighter receptacle into which the adapter of the present invention is plugged;

Fig. 2 is a schematic circuit diagram of the monaural adapter including the connection to the external power supply and audio input from the stereo cassette player;

Fig. 3 is a schematic circuit diagram of the stereophonic version of the circuit; and

Fig. 4 is a schematic circuit diagram of a modification of the circuit of Fig. 3, where a custom chip is employed in lieu of certain discrete components of Fig. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in Figures 1 and 2, the adapter 10 includes a plug 12, which is in the form of a standard car cigarette lighter plug that fits into the cigarette lighter receptacle 14 of the car, which is connected to the car battery or direct voltage source 16. The direct voltage is connected through positive and negative terminals 18 through a first resistor 20, which may provide a reduced voltage if desired, to a power filter and decoupling network including inductances or coils 22, 24 and electrolytic capacitors 26, 28, which filter out ignition

noise and provide filtered direct voltage to an oscillator-modulator transistor stage 30. Resistors 32, 34, 36 provide proper direct voltage bias to the base and emitter electrodes of transistor 30.

Audio input from a portable stereo cassette tape player (not shown) is obtained from a standard stereo miniature plug 38 which is plugged into the receptacle of the tape player normally connected to a pair of earphones of a head set. The audio input for the right and left ear pieces are added together through resistors 40, 42 and the third wire connection to the audio input plug provides a ground 44 connected through coil 43. The resistors reduce the audio input signal to a desired usable level while the coils aid in filtering out undesired radio frequency signals. The low frequency audio signal is fed into the base electrode of transistor 30 through electrolytic coupling capacitor 46, while capacitors 48, 50 serve to bypass the radio frequency (RF) signal emanating from the oscillator and prevent the higher RF signal from being coupled into the audio input connector, as well as minimize any undesired tuning effects caused by the length of the input cord.

A feedback capacitor 52 between the collector and emitter electrodes of transistor 30 provides a positive feedback to initiate oscillation, while inductance or coil 54 and variable capacitor 56 form a tuned circuit which oscillates at a desired frequency that is adjustable in the FM band between 88-108 MHz. The audio signal modulates the base-to-collector capacitance of transistor 30 and thus frequency modulates the oscillator. The frequency modulated output of the oscillator is taken from the low impedance emitter electrode and coupled through capacitor 58 to the positive terminal of the cigarette lighter plug 12 which connects to the positive battery terminal of the car. The emitter output provides an

impedance match between the oscillator-modulator stage and the car battery. In addition, resistor 20 provides a constant load on the radio antenna and output transistor. This prevents tuning changes that may result from the RF being fed into the positive terminal of the power supply which has a low impedance to ground that changes with load on the battery. Due to imperfect shielding and stray capacitance 60 of the wires connected to the battery and the proximity to the car radio antenna 62 and input stage, the relatively weak microwave frequency modulated signal from the adapter is coupled through the cigarette lighter plug into the FM car radio 64. No separate amplifier or direct connection to the car radio antenna or input stage are necessary.

The radio is set to an unused frequency within the FM band which is between local stations in order to avoid interference. The tuning capacitor 56 is then manually adjusted until the audio signal is heard clearly at the frequency setting of the radio, with the FM radio providing the necessary amplification so that the audio signal from the tape player is heard over the car radio loud speakers 66. The use of frequency modulation by the adapter in conjunction with the car FM radio inherently provides a relatively noise free clear audio signal from an external tape player without requiring an expensive tape deck installation. Since the adapter unit operates on extremely low power, no on-off switch is necessary. However, by simply pulling the plug out of the cigarette lighter receptacle a small amount, the small light weight unit is disconnected from the power source and can actually be held or stored in the receptacle without being on.

Typical values for the various components of the adapter are as follows:

Resistor 20	470 ohms
Resistor 24	100 ohms
Resistor 32	10K ohms
Resistor 34	2.7K ohms
Resistor 36	2.7K ohms
Resistor 40	50 ohms
Resistor 42	50 ohms
Coil 22	100 microhenries
Coil 24	100 microhenries
Coil 41	100 microhenries
Coil 43	100 microhenries
Coil 54	0.1 microhenries
Capacitor 26	50 microfarads at 50 volts
Capacitor 28	50 microfarads at 50 volts
Capacitor 46	.22 microfarads at 16 volts
Capacitor 48	.00s microfarads
Capacitor 50	470 picofarads
Capacitor 52	10 picofarads
Capacitor 56	21-23 picofarads
Capacitor 58	39 picofarads
Transistor 30	2N3904

Fig. 3 is a schematic diagram of the stereophonic adapter circuit. In Fig. 3, numerals 2 and 4 denote the inputs to the stereophonic circuit of the right and left-hand stereo channels of the portable cassette recorder or compact disc player. Numeral 1 is the standard plug for the vehicle's cigarette lighter. As will be seen, the cigarette lighter plug 1 couples the output of the stereophonic circuit to the remainder of the vehicle's wiring system, as well as providing a source to power the circuit through the cigarette lighter receptacle provided on the vehicle. This power source in the present circuit consists of a 12-volt section which

provides 12-volt power to those circuits requiring the same, which as described above consists of a power filter and decoupling network including inductance coil 3 and capacitor 4. The 12-volt is then regulated to 5 volts by 5-volt voltage regulator 6.

Electrical lead 7 connected to tje cigarette lighter plug 1 couples the modulated FM signal to the cigarette lighter plug for connection to the remaining vehicle circuitry. Generation of this frequency modulated signal will now be discussed.

The output, from the right and left hand channels of the cassette recorder, terminals 2 and 4, are connected via blocking capacitors 11 and 13 directly to a switch 15. The blocking capacitors are coupled between respective resistors 9 and 10 and ground via lead 8, and resistors 17 and 19 ground via lead 21.

The switch 15 is designed to chop the right and left hand stereo signals from the recorder. The switch points for the right and left hand are connected to the output of the switch at different times all under control of the output of divide-by-two circuit 23.

As is known, an FM stereo signal requires a 19 KHz pilot tone which must be extremely stable. The present circuit generates this pilot tone by utilizing a precision oscillator 25 generating an output at 76 KHz. The output of the oscillator 25 is coupled to one input 27 of divide-by-two divider 23. The output of this divide-by-two circuit, at terminal 50, is coupled to the chopper switch 15. The other output, which is the complement of the output of terminal 50, is coupled from terminal 49 to the other input of chopper switch 15.

Thus, the switch 15 under control of a 38 KHz sampling rate generates a signal at the output of the switch which represents a multiplexed version of the left and right input channels from the stereo player. Another divide-by-two circuit, 29, is connected to receive the 38 KHz output from the first divide-by-two circuit 23. This generates, at terminal 59, the 19 KHz stable square wave frequency necessary for stereophonic transmission. The square wave is converted to a sine wave via filter 61. This filter 60 includes inductors 70 and 72 and capacitors 68, 74, 76, 78 and 80. The sine wave output from filter 61 is coupled to amplifier and phase adjusting circuits 31 and 33. The sine wave thus generated is connected to transistor 35 which couples it to junction point 81 of resistors 82 and 84. At junction 81, the 19 KHz pilot signal is combined with the multiplexed left and right channels.

As indicated, multiplexed left and right channels appear at the output of switch 15. The signals are, in turn, coupled via resistor 37 and capacitor 47 to amplifier 49. This amplifying circuit is connected to a filter 86 which includes inductors 88 and 94 and capacitors 90, 92 and 96. This filter protects the multiplexed left and right audio signal from all frequencies above the audio range. Thus, these higher frequency signals are filtered out by filter 86. The multiplexed signal, time filtered, is coupled to transistor 51 connected in a phase shift circuit which includes resistor 53 and capacitor 55. This phase shift generates a delay necessary for proper separation of the two stereo channels during later decoding. The output of transistor 51 is coupled to the input of an amplifier 57. The output of the amplifier 57 is coupled via resistor 82 to junction 81. The signal at terminal 81 is coupled via resistors 63 and 100 to the input of RF oscillator 65. Filtering is provided by RC circuit 102 and 104 to improve the signal-tonoise ratio.

The RF oscillator 65 is the same circuit which was described in the monaural version as including transistor 30. Specifically, feedback capacitor 67 connected between the collector and emitter electrodes of transistor 65 provides a positive feedback to initiate oscillations while inductor 98 and capacitor 69 form a tuned circuit which oscillates at desired frequencies that are adjustable in the FM band between 88-108 MHz. The inductor 98 is shown as a variable in the stereophonic embodiment described while capacitor 56 was varied in the monaural embodiment.

The audio signal modulates the base-to-collector capacitance of transistor 65 and thus frequency modulates the oscillator. The frequency-modulated output of the oscillator is taken from the low impedance emitted electrode and coupled inductively to the cigarette lighter plug via another amplification stage which includes transistor 71. Transistor 71, a buffer amplifier, amplifies the signal and couples it through capacitor 73 to the cigarette lighter plug 1.

The radio is set to an unused frequency within the FM band which is between local stations in order to avoid interference. The tuning inductor 98 is then manually adjusted until the audio signal is heard clearly at the frequency setting of the radio, with the RM radio providing stereophonic amplification so that the audio signal from the player is heard stereo phonically over the car radio speakers.

Typical values for the various circuit components of the circuit of Fig. 3 are as follows:

Resistor 1	1.0K ohm
Resistor 2	20K ohm variable
Resistor 3	4.7K ohm
Resistor 4	10K ohm
Resistor 5	76K ohm
Resistor 6	5K ohm variable
Resistor 7	1.5K ohm
Resistor 8	10K ohm
Resistor 9	22K ohm
Resistor 10	1K ohm
Resistor 11	1K ohm
Resistor 12	2.2K ohm variable
Resistor 13	47K ohm
Resistor 14	47K ohm
Resistor 15	10K ohm
Resistor 16	4.7K ohm
Resistor 17	15K ohm
Resistor 18	10K ohm variable
Resistor 19	10K ohm
Resistor 20	2.2K ohm variable
Resistor 21	1.5K ohm
Resistor 22	3.3K ohm
Resistor 23	10K ohm variable
Resistor 24	3.3K ohm
Resistor 25	10K ohm
Resistor 26	4.7K ohm variable
Resistor 27	4.7K ohm
Resistor 28	4.7K ohm
Resistor 29	2.2K ohm
Resistor 30	10K ohm
Resistor 31	1K ohm
Resistor 32	10K ohm
Resistor 33	47K ohm
Resistor 34	100K ohm
Resistor 35	100K ohm
Resistor 36	100K ohm
Resistor 37	100K ohm

Resistor 38	100K ohm
Resistor 39	47K ohm
Resistor 40	100 ohm
Resistor 41	39K ohm
Resistor 42	330 ohm
Resistor 43	47 ohm
Resistor 44	100 ohm
Capacitor 1	.0015 microfarad
Capacitor 2	.1 microfarad
Capacitor 3	.01 microfarad
Capacitor 4	.0022 microfarad
Capacitor 5	330 picofarad
Capacitor 6	.0033 microfarad
Capacitor 7	.0022 microfarad
Capacitor 8	.0012 microfarad
Capacitor 9	.1 microfarad
Capacitor 10	.01 microfarad
Capacitor 11	.01 microfarad
Capacitor 12	.1 microfarad
Capacitor 13	470 picofarad
Capacitor 14	470 picofarad
Capacitor 15	22 picofarad
Capacitor 16	470 microfarad Electrolytic
Capacitor 17	100 microfarad Electrolytic
Capacitor 18	68 picofarad
Capacitor 19	.001 microfarad
Capacitor 20	.0025 microfarad
Capacitor 21	720 picofarad
Capacitor 22	.1 microfarad
Capacitor 23	.1 microfarad
Capacitor 24	.1 microfarad
Capacitor 25	120 picofarad
Capacitor 26	33 picofarad
Capacitor 27	11 picofarad
Capacitor 28	6 picofarad
Capacitor 29	15 picofarad
Capacitor 30	33 picofarad

Capacitor 31	.01 microfarad
Capacitor 32	.1 microfarad
Capacitor 33	100 microfarad Electrolytic
Capacitor 34	10 picofarad
Capacitor 35	.1 microfarad
Capacitor 36	100 microfarad Electrolytic
Capacitor 37	100 microfarad Electrolytic
Capacitor 38	.001 microfarad
Transistor 1	2N3906
Transistor 2	2N3906
Transistor 3	2N3906
Transistor 4	2N3906
Transistor 5	2N3906
Transistor 6	2SC2620
Transistor 7	2SC2620
Coil 1	22 millihenry
Coil 2	7 millihenry
Coil 3	11 millihenry
Coil 4	8 millihenry
Coil 5	.22 microhenry
Coil 6	200 microhenry

Fig. 4 is a modification of the schematic of Fig. 3. The simplification is occasioned by substituting a custom chip for many of the discrete components shown in Fig. 3. As the chip of Fig. 4 requires a +10 volt source, buffer amplifier 71 is not required.

Specifically, in Fig. 4, a chip 83 incorporates the discrete components of Fig. 3 in front of Resistor 39, and Capacitor 25. The remaining circuit components of Fig. 3 (with the exception of buffer amplifier 71 and associated circuitry, and the use of a crystal oscillator 87 in lieu of precision oscillator 25) correspond to comparable portions of Fig. 3. Thus, transistor 85 and the tune circuit of capacitor 91 and inductor 93 correspond to transistor 65, capacitor 69 and inductor 98 of

Fig. 3. The plug for the cigarette lighter is designated by numeral 75. The right channel, left channel and ground connections of the tape or compact disc player are denoted by numerals 77, 79 and 81 respectively.

The lighter plug 75 is connected to integrated circuit 83 via inductor 97, capacitor 99, resistor 101 and Zener diode 103. This portion of the circuit supplies power to integrated circuit 83 corresponding to the functions of inductor 3, capacitor 5 and regulator 6 in Fig. 3. The output of transistor 85 is connected to the plug 75 via line 107, blocking capacitor 109 and resistor 111. Lead 105 connects the junction of inductor 97 and capacitor 99 to the base of transistor 85.

As will now be understood, the simplified embodiment of Fig. 4 functions in the same manner as the discrete components shown in Fig. 3. The Fig. 4 version is more suitable to the demands of the commercial market-place.

Typical values for the various circuit components of the circuit of Fig. 4 are as follows:

Resistor 1	330 ohm
Resistor 2	330 ohm
Resistor 3	220K ohm
Resistor 4	220K ohm
Resistor 5	33K ohm
Resistor 6	33K ohm
Resistor 7	1.2K ohm
Resistor 8	180K ohm
Resistor 9	10K ohm
Resistor 10	47K ohm
Resistor 11	2.7K ohm
Resistor 12	300 ohm
Resistor 111	330 ohm

Resistor 101	3.3K ohm
Variable Resistor 1	500K ohm Trimmer
Capacitor 1	1 microfarad 16V Tant.
Capacitor 2	1 microfarad 16V Tant.
Capacitor 3	270 picofarad
Capacitor 4	270 picofarad
Capacitor 5	.033 microfarad
Capacitor 6	.033 microfarad
Capacitor 109	10 microfarad 6.3V Tant.
Capacitor 8	100 picofarad
Capacitor 9	10 picofarad
Capacitor 10	270 picofarad
Capacitor 11	1 microfarad 16V Tant.
Capacitor 12	120 picofarad
Capacitor 13	20 picofarad NPO
Capacitor 14	11 picofarad NPO
Capacitor 15	.01 microfarad
Capacitor 16	22 microfarad Tant.
Capacitor 17	10 picofarad
Capacitor 18	47 microfarad 50V Electrolytic
Integrated Circuit 83	14 pin surface mount
Coil 93	Coilcraft .1 microhenry variable
Coil 97	200 microhenry
Coil 3	200 microhenry
Coil 4	200 microhenry
Zener 103	1.7V
Zener 2	10V
Transistor 85	2SC2620

While various embodiments have been illustrated and described, it is apparent that many further variations may be made in the particular designs and configurations without departing from the scope of the invention as set forth in the appended claims.

What is claimed is:

1. A device for coupling an audio signal from an external source to an automobile radio comprising:

a transistor modulator-oscillator stage including tuning means for establishing a selected frequency of said oscillation and means for connecting said audio signal to said oscillator for modulating said oscillation frequency;

said audio signal converting means, including switch means for multiplexing stereophonic input signals at a first frequency and means for modulating said multiplexed signal on to carrier frequency signal of a fixed frequency, said modulated carrier frequency signal being utilized as the input to said modulator oscillator stage.

2. In a device for coupling stereophonic external audio signals to a car radio, the combination of means for generating a fixed frequency pilot tone signal; means for receiving said external audio stereophonic signal and for generating a first multiplexed signal indicative of the right and left channel with said stereophonic signal; and means for modulating said fixed frequency signal with said multiplexed stereophonic signal.

3. The device of Claim 2 further including a modulator-oscillator for receiving said modulated stereophonic fixed frequency signal and generating an output signal therefrom at a frequency in the FM band modulated by said stereophonic signal.

4. The circuit of Claim 3 wherein said modulated stereophonic from said oscillator is connected to the car radio.

5. Apparatus for connecting a stereo signal generator to the radio of the vehicle, said apparatus, comprising:

a multiplexing switch;

input terminals connected to said multiplexing switch, said input terminals adapted to receive the left and right channels of a stereo signal generating device;

means for switching said switch means at a sampling frequency;

means connected to the output of said switch means for generating an electrical signal indicative of said left and right channels respectively of said stereo signal;

means for generating a fixed stable frequency tone signal, means connected to receive said tone signal and said multiplexed stereo signal for developing a modulator control signal;

means connected to receive said modulator control signal for generating an output signal modulated by said modulator control signal; and

means connected to the output of said modulator control signal for conveying same to the radio of the vehicle.

6. A stereo adapter, comprising:

means for generating a multiplexed signal indicative of a stereo input signal;

means for combining said multiplexed signals with a fixed frequency reference signal;

means connected to receive said combined fixed frequency reference multiplexed stereo signal for generating an output signal indicative of said stereo signal; and

means for connecting said output signal to the radio of a vehicle.

7. A coupling device for connecting a stereo signal to a vehicle radio said device comprising:

a modulator-oscillator connected to the radio of the vehicle; and

means for generating an electrical signal for modulating said modulator-oscillator, said electrical signal being indicative of the stereo input to said device, said stereo input being multiplexed to a single signal sampled at a fixed frequency rate and combined with a second fixed frequency signal.

8. A device for coupling an audio signal from an external source to an automobile radio, said radio including an antenna, an input stage, and an output stage and a loud-speaker, and a connection to the automobile source of direct voltage, comprising:

input means for connecting said audio signal source;

output means for coupling an output signal to said radio input stage and for connection to said direct voltage source;

a transistor modulator-oscillator stage;

means for modulating said transistor modulator-oscillator with a control signal; and

means for generating said control signal by multiplexing the right and left channels of a stereo input signal and combining said multiplexed input signal with a second signal of fixed frequency.

9. A device for coupling an audio signal from an external source to an automobile radio, said radio including an antenna, an input stage, and an output stage having a loud speaker, and a connection to the automobile source of direct voltage, comprising:

input means for connecting to said audio signal source;

output means for coupling an output signal to send radio input stage and for connecting to said direct voltage source;

a transistor modulator-oscillator stage;

filter means connected to said output means and direct voltage source for providing a filtered direct voltage to operate said modulator-oscillator;

signal coupling means for applying said audio signal from said input means to an input electrode of said transistor;

feedback means for causing radio frequency oscillation of said transistor;

tuning means for establishing a selected frequency of said oscillation, said oscillation frequency being modulated by said audio signal to provide an output signal; and

means for connecting said output signal to said output means to apply said output signal to said radio to be heard over said radio loudspeaker.

10. The device of Claim 9 wherein said connection to said automobile source of direct voltage is a cigarette lighter receptacle and said output means is a cigarette lighter plug insertable into said receptacle, said output signal being coupled into said radio input stage by said receptacle through stray capacitance of wires connected to said direct voltage source and by proximity to said antenna and input stage.

11. The device of Claim 10 wherein said external source of audio signal is a tape player having an output receptacle and said input means is a plug insertable into said output receptacle.

12. The device of Claim 11 wherein said automobile radio is a frequency modulation receiver, said transistor modulator oscillator providing an oscillation frequency in the frequency modulation band, said audio signal modulating said oscillation frequency to provide a frequency modulated output signal.

13. The device of Claim 12 wherein said tuning means is adapted to select a frequency in the frequency modulation receiver band between local stations to permit weak audio signals to be coupled into said radio to be heard over the radio loudspeaker.

14. The device of Claim 13 wherein said external audio signal source is a portable stereo cassette player providing two signals, said input means plug being a stereo miniature plug, and said signal coupling means includes a pair of resistors for combining said two signals.

15. The device of Claim 14 including bias means connected between said filter means and transistor electrodes providing direct operating voltages to said electrodes.

16. The device of Claim 15 wherein said means for connecting said output signal includes a capacitor connected between the emitter output electrode of said transistor and said cigarette lighter plug.

17. The device of Claim 16 wherein said tuning means includes a coil and tuning capacitor connected in parallel and to the collector electrode of said transistor.

18. The device of Claim 17 wherein said signal coupling means includes a capacitor connected between said input means plug and the base electrode of said transistor.

19. The device of Claim 18 wherein said feedback means includes a capacitor connected between said collector and emitter electrodes.

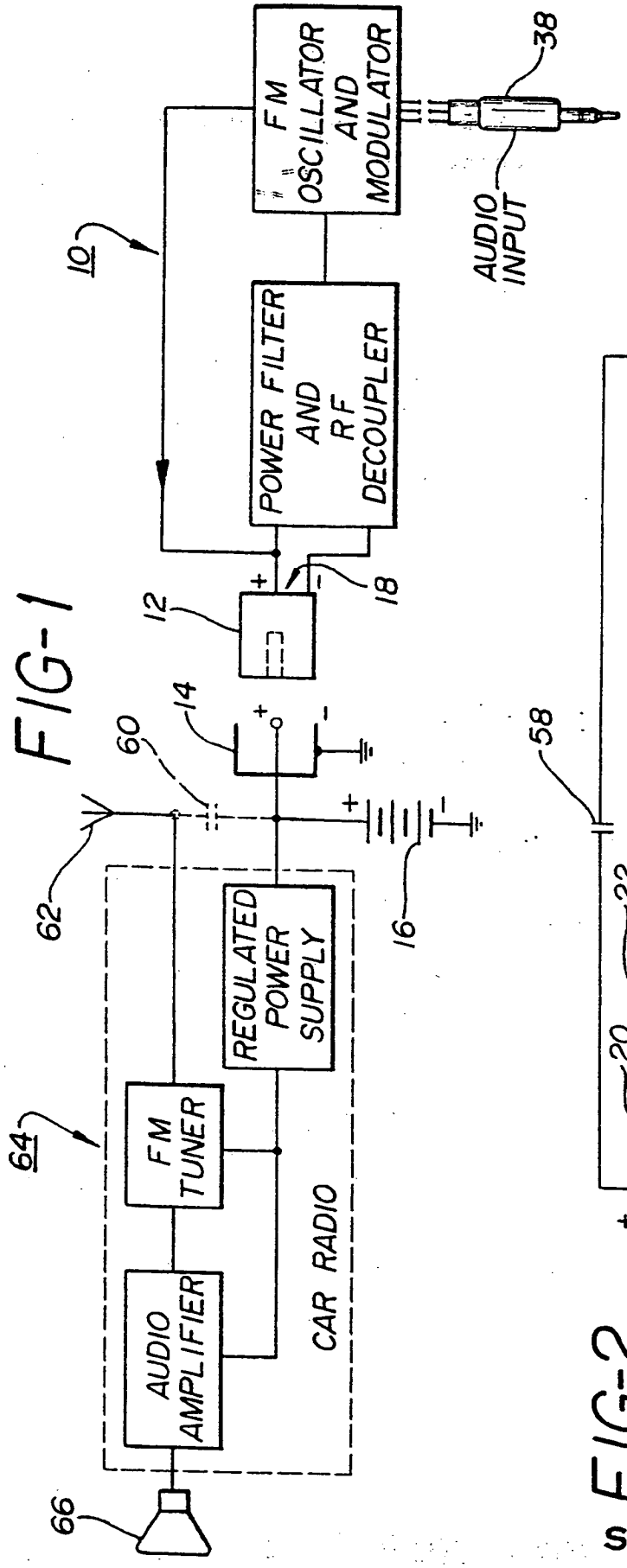


FIG-1

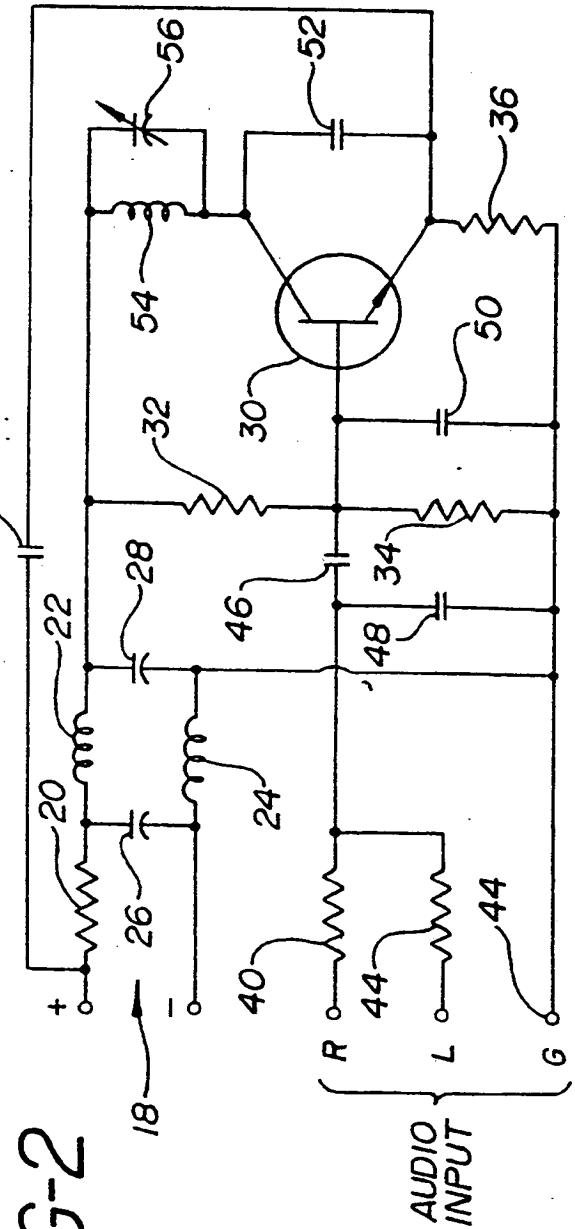


FIG-2

FIG-3A

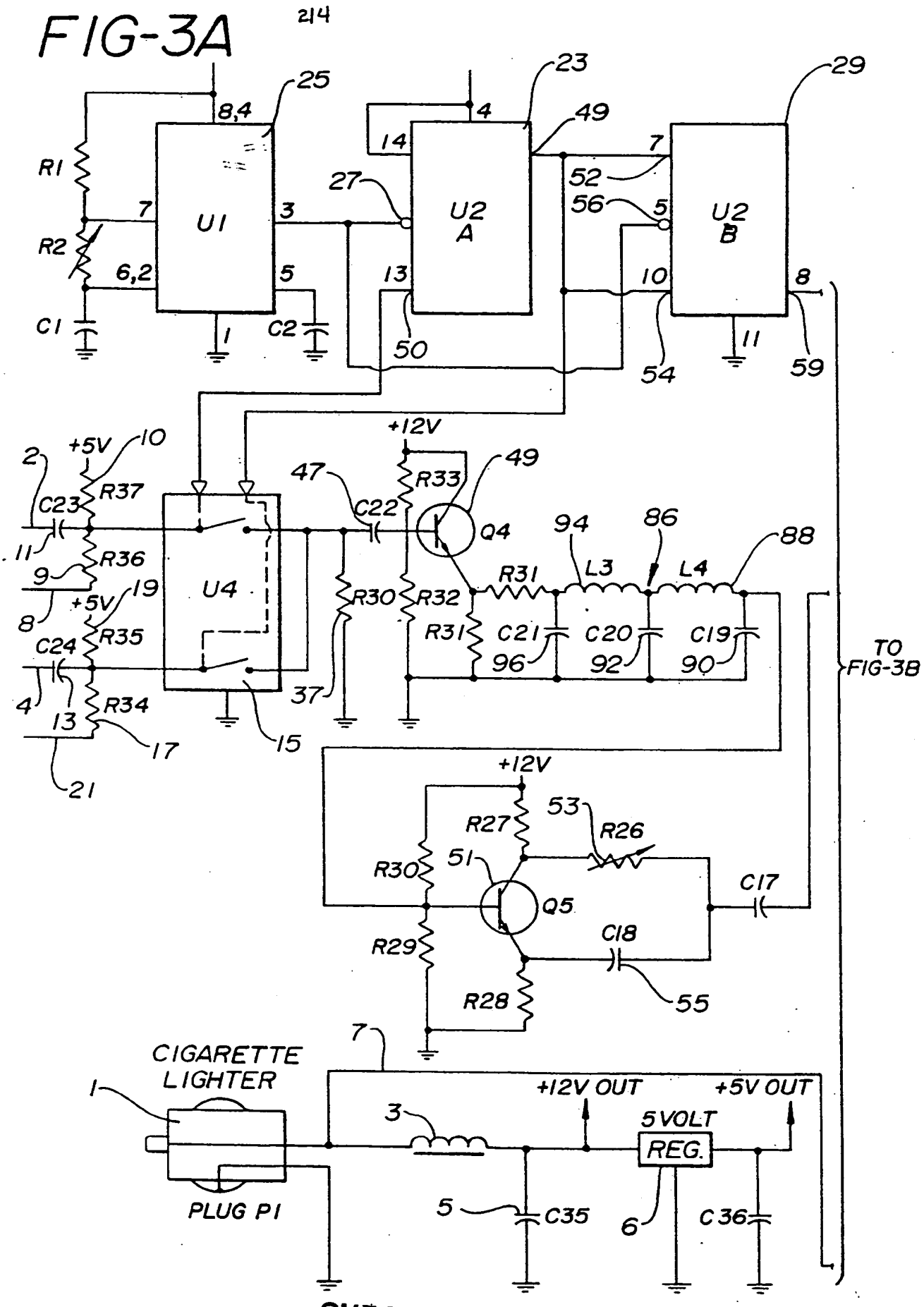
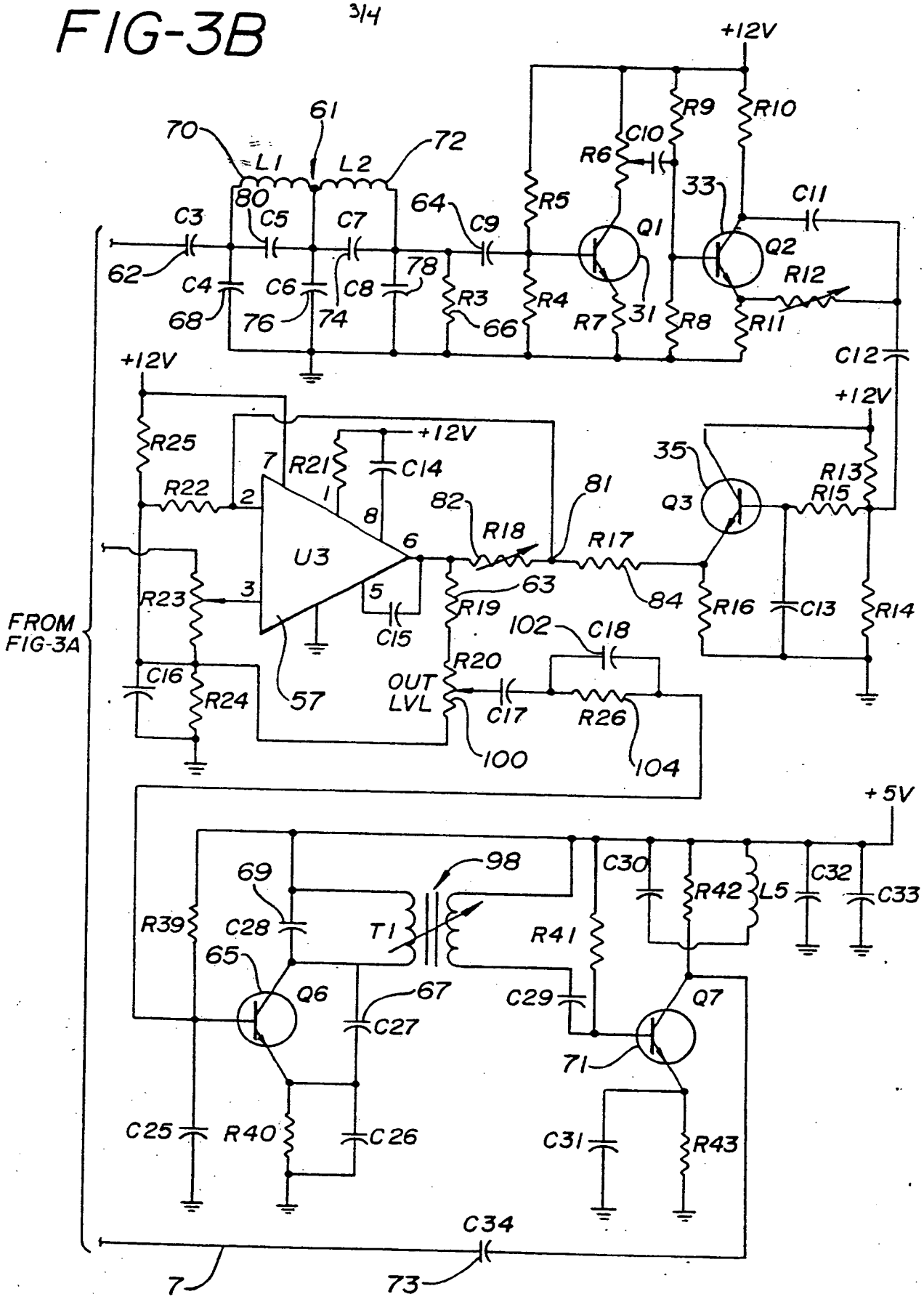

214
25
23
29
8,4
4
49
14
7
R1
27
U1
U2 A
52
56
5
U2 B
7
3
R2
6,2
5
13
10
8
C1
C2
50
54
11
59
+12V
+5V
10
2
47
49
R33
C23
R37
C22
Q4
94
86
88
11
R36
R31
L3
L4
9
U4
R30
R32
19
+5V
8
R31
C21
C20
C19
C24
R35
96
92
90
TO FIG-3B
4
13
R34
37
17
15
21
+12V
53
R27
R26
R30
51
C17
Q5
R29
C18
55
R28
7
CIGARETTE LIGHTER
+12V OUT
+5V OUT
1
3
5VOLT
REG.
PLUG P1
5
C35
6
C36

FIG-3B



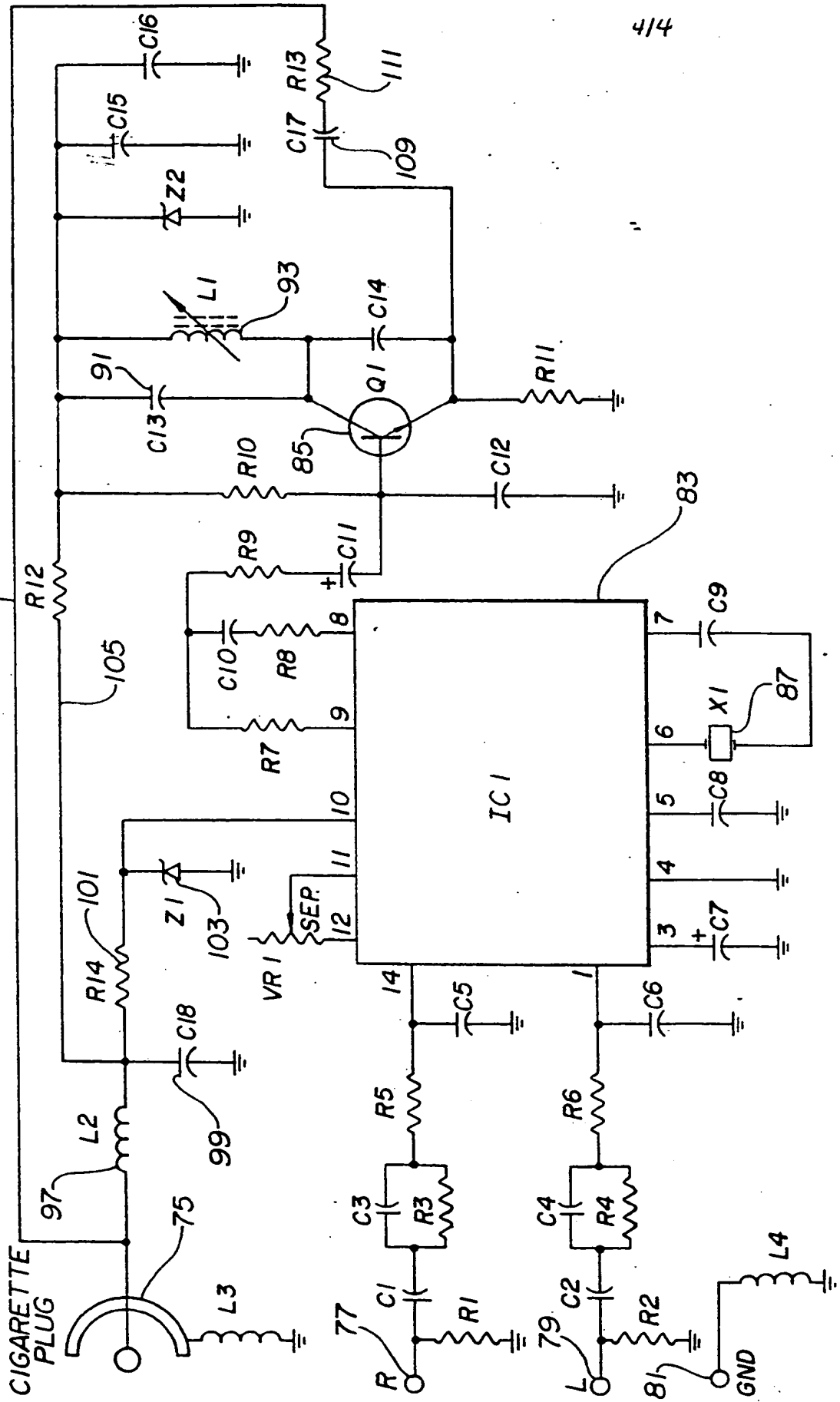

C16
C15
Z2
C17
R13
111
109
L1
93
C14
91
C13
Q1
R11
85
R10
C12
83
107
R12
R9
C11
105
C10
R8
R7
IC 1
C9
X1
87
C8
101
R14
Z1
103
SEP.
VR 1
C18
99
C5
C6
C7
L2
97
75
R5
R6
C3
R3
C4
R4
CIGARETTE PLUG
L3
77
C1
R1
79
C2
R2
L4
R
L
81
GND

FIG-4

INTERNATIONAL SEARCH REPORT

International Application No PCT/US86/01634

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL.[4] H04H 5/00; H04B 1/034
U.S. CL. 381/7; 455/99

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	455/41,99,142,144,344,345 369/6,8 381/3,4,7

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US, A, 2,959,644 (Grace) 08 November 1960	
Y	US, A, 3,751,601 (Wally) 07 August 1973 see Abstract, Figure 2, and columns 1-3	1-19
Y	US, A, 4,194,161 (Hershberger) 18 March 1980 see Abstract, Figure 2, and column 2	1-8,14-19
Y	US, A, 4,264,784 (Lorea) 28 April 1981 see Abstract and Figure 7	1-8,14-19
Y	US, A, 4,354,275 (Bouyssounouse et al) 12 October 1982 see Figure 4 and column 3, line 25 and column 4, lines 33-42	10-18
Y	US, A, 4,481,658 (Schmidt) 06 November 1984 see Abstract, Figures 1 and 2, and column 1	1-8,14-19
A	US, A, 4,507,646 (Hamlin et al) 26 March 1985	

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
12 SEPTEMBER 1986	06 OCT 1986
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	F.W. Isen

Form PCT/ISA/210 (second sheet) (May 1986)